

WHAT IS CLAIMED IS:

1           1.       A method of recovering data in a database of a database system stored in a  
2   datastore connected to a computer, the method comprising:  
3           scanning a database log, wherein the database log records activities related to the  
4   database; and  
5           identifying one or more individual objects to be recovered to a target time with  
6   reference to a backup time.

1           2.       The method of claim 1, wherein the target time is user-defined.

1           3.       The method of claim 1, wherein the backup time is user-defined.

1           4.       The method of claim 1, further comprising analyzing the database log to  
2   detect when a unit of recovery begins and when the unit of recovery ends.

1           5.       The method of claim 4, wherein an object is not recovered when the unit of  
2   recovery accessing that object ends before the target time and there are no pending writes for  
3   the object.

1           6.       The method of claim 5, wherein the unit of recovery begins and ends before a  
2   checkpoint time, and wherein the checkpoint time occurs before the target time.

1           7.       The method of claim 5, wherein the unit of recovery begins before a  
2   checkpoint time, and wherein the unit of recovery ends after the checkpoint time but before  
3   the target time.

1           8.       The method of claim 5, wherein the unit of recovery begins after a checkpoint  
2   time, and wherein the unit of recovery ends before the target time.

1           9.     The method of claim 4, wherein an object is recovered if the unit of recovery  
2 begins before the target time, and wherein the unit of recovery ends after the target time but  
3 before a current time, wherein the current time represents when object data is recorded to the  
4 database.

1           10.    The method of claim 9, wherein the unit of recovery begins before a  
2 checkpoint time.

1           11.    The method of claim 9, wherein the unit of recovery begins after a checkpoint  
2 time but before the target time.

1           12.    The method of claim 4, wherein an object is recovered if the unit of recovery  
2 begins after the target time, and wherein the unit of recovery ends before a current time,  
3 wherein the current time represents when object data is recorded to the database.

1           13.    The method of claim 1, wherein a backup is taken.

1           14.    The method of claim 13, wherein the backup occurs prior to the target time  
2 and further comprising restoring data without restoring the database log.

1           15.    The method of claim 13, wherein the backup occurs after the target time and  
2 further comprising restoring data and optionally restoring the database log.

1           16.    The method of claim 13, further comprising restarting the database system  
2 with a conditional restart with defer all option.

1           17.    The method of claim 1, further comprising flushing cache data to disk.

1           18.     The method of claim 1, further comprising truncating the database log at the  
2     target time.

1           19.     The method of claim 18, further comprising disabling access to the database  
2     and restarting the database system, wherein restarting detects uncommitted units of recovery.

1           20.     The method of claim 19, further comprising creating a compensation log and  
2     appending the compensation log to the truncated database log beginning from the target time.

1           21.     The method of claim 1, further comprising restoring the identified objects.

1           22.     The method of claim 21, further comprising determining whether the database  
2     log should be applied to the restored objects to update the identified objects with current  
3     object data.

1           23.     The method of claim 22, when the determination is made to apply the  
2     database log to the identified objects, further comprising optimizing the identified objects  
3     such that the identified objects may be restored without applying the database log to the  
4     identified objects.

1           24.     The method of claim 23, if the objects can not be optimized, applying the  
2     database log to the restored objects.

1           25.     The method of claim 21, after restoring the identified objects, further  
2     comprising providing access to the identified objects.

1           26.     The method of claim 1, further comprising optimizing the identified objects  
2     by restoring a volume of the datastore and recovering corresponding objects.

1           27.     The method of claim 1, further comprising optimizing the identified objects  
2 by grouping the identified objects, wherein the grouped objects have backups residing on the  
3 same volume of the datastore.

1           28.     The method of claim 1, wherein an object is associated with different units of  
2 recovery, wherein one or more units of recovery require different levels of processing, and  
3 wherein the object is recovered utilizing the highest level of processing.

1           29.     The method of claim 1, wherein the one or more individual objects to be  
2 recovered to a target time are recovered from a current time.

1           30.     The method of claim 29, wherein the current time represents at time at which  
2 the database system crashed.

1           31.     An apparatus for recovering data in a database of a database system,  
2 comprising:  
3 a computer having a data store connected thereto, wherein the data store stores data;  
4 and  
5 one or more computer programs, performed by the computer, for scanning a database  
6 log, wherein the database log records activities related to the database and for identifying one  
7 or more individual objects to be recovered to a target time with reference to a backup time.

1           32.     The apparatus of claim 31, wherein the target time is user-defined.

1           33.     The apparatus of claim 31, wherein the backup time is user-defined.

1           34.     The apparatus of claim 31, further comprising analyzing the database log to  
2 detect when a unit of recovery begins and when the unit of recovery ends.

1           35.     The apparatus of claim 34, wherein an object is not recovered when the unit of  
2 recovery accessing that object ends before the target time and there are no pending writes for  
3 the object.

1           36.     The apparatus of claim 35, wherein the unit of recovery begins and ends  
2 before a checkpoint time, and wherein the checkpoint time occurs before the target time.

1           37.     The apparatus of claim 35, wherein the unit of recovery begins before a  
2 checkpoint time, and wherein the unit of recovery ends after the checkpoint time but before  
3 the target time.

1           38.     The apparatus of claim 35, wherein the unit of recovery begins after a  
2 checkpoint time, and wherein the unit of recovery ends before the target time.

1           39.     The apparatus of claim 34, wherein an object is recovered if the unit of  
2 recovery begins before the target time, and wherein the unit of recovery ends after the target  
3 time but before a current time, wherein the current time represents when object data is  
4 recorded to the database.

1           40.     The apparatus of claim 39, wherein the unit of recovery begins before a  
2 checkpoint time.

1           41.     The apparatus of claim 39, wherein the unit of recovery begins after a  
2 checkpoint time but before the target time.

1           42.     The apparatus of claim 34, wherein an object is recovered if the unit of  
2 recovery begins after the target time, and wherein the unit of recovery ends before a current  
3 time, wherein the current time represents when object data is recorded to the database.

1 43. The apparatus of claim 31, wherein a backup is taken.

1 44. The apparatus of claim 43, wherein the backup occurs prior to the target time  
2 and further comprising restoring data without restoring the database log.

1 45. The apparatus of claim 43, wherein the backup occurs after the target time and  
2 further comprising restoring data and optionally restoring the database log.

1 46. The apparatus of claim 43; further comprising restarting the database system  
2 with a conditional restart with defer all option.

1 47. The apparatus of claim 31, further comprising flushing cache data to disk.

1 48. The apparatus of claim 31, further comprising truncating the database log at  
2 the target time.

1 49. The apparatus of claim 48, further comprising disabling access to the database  
2 and restarting the database system, wherein restarting detects uncommitted units of recovery.

1 50. The apparatus of claim 49, further comprising creating a compensation log  
2 and appending the compensation log to the truncated database log beginning from the target  
3 time.

1 51. The apparatus of claim 31, further comprising restoring the identified objects.

1 52. The apparatus of claim 51, further comprising determining whether the  
2 database log should be applied to the restored objects to update the identified objects with  
3 current object data.



2 a computer and embodying one or more instructions executable by the computer for  
3 recovering data in a database of a database system, comprising:  
4 scanning a database log, wherein the database log records activities related to the  
5 database; and  
6 identifying one or more individual objects to be recovered to a target time with  
7 reference to a backup time.

1           62.     The article of manufacture of claim 61, wherein the target time is user-  
2     defined.

1           63.     The article of manufacture of claim 61, wherein the backup time is user-  
2     defined.

1           64.     The article of manufacture of claim 61, further comprising analyzing the  
2     database log to detect when a unit of recovery begins and when the unit of recovery ends.

1           65.    The article of manufacture of claim 64, wherein an object is not recovered  
2    when the unit of recovery accessing that object ends before the target time and there are no  
3    pending writes for the object.

1           66.     The article of manufacture of claim 65, wherein the unit of recovery begins  
2     and ends before a checkpoint time, and wherein the checkpoint time occurs before the target  
3     time.

1           67.     The article of manufacture of claim 65, wherein the unit of recovery begins  
2     before a checkpoint time, and wherein the unit of recovery ends after the checkpoint time but  
3     before the target time.



1           68.     The article of manufacture of claim 65, wherein the unit of recovery begins  
2 after a checkpoint time, and wherein the unit of recovery ends before the target time.

1           69.     The article of manufacture of claim 64, wherein an object is recovered if the  
2 unit of recovery begins before the target time, and wherein the unit of recovery ends after the  
3 target time but before a current time, wherein the current time represents when object data is  
4 recorded to the database.

1           70.     The article of manufacture of claim 69, wherein the unit of recovery begins  
2 before a checkpoint time.

1           71.     The article of manufacture of claim 69, wherein the unit of recovery begins  
2 after a checkpoint time but before the target time.

1           72.     The article of manufacture of claim 64, wherein an object is recovered if the  
2 unit of recovery begins after the target time, and wherein the unit of recovery ends before a  
3 current time, wherein the current time represents when object data is recorded to the  
4 database.

1           73.     The article of manufacture of claim 61, wherein a backup is taken.

1           74.     The article of manufacture of claim 73, wherein the backup occurs prior to the  
2 target time and further comprising restoring data without restoring the database log.

1           75.     The article of manufacture of claim 73, wherein the backup occurs after the  
2 target time and further comprising restoring data and optionally restoring the database log.

1           76.     The article of manufacture of claim 73, further comprising restarting the  
2 database system with a conditional restart with defer all option.

1           77.     The article of manufacture of claim 61, further comprising flushing cache data  
2 to disk.

1           78.     The article of manufacture of claim 61, further comprising truncating the  
2 database log at the target time.

1           79.     The article of manufacture of claim 78, further comprising disabling access to  
2 the database and restarting the database system, wherein restarting detects uncommitted units  
3 of recovery.

1           80.     The article of manufacture of claim 79, further comprising creating a  
2 compensation log and appending the compensation log to the truncated database log  
3 beginning from the target time.

1           81.     The article of manufacture of claim 61, further comprising restoring the  
2 identified objects.

1           82.     The article of manufacture of claim 81, further comprising determining  
2 whether the database log should be applied to the restored objects to update the identified  
3 objects with current object data.

1           83.     The article of manufacture of claim 82, when the determination is made to  
2 apply the database log to the identified objects, further comprising optimizing the identified  
3 objects such that the identified objects may be restored without applying the database log to  
4 the identified objects.

1           84.     The article of manufacture of claim 83, if the objects can not be optimized,  
2 applying the database log to the restored objects.

85. The article of manufacture of claim 81, after restoring the identified objects,  
further comprising providing access to the identified objects.

1           86.     The article of manufacture of claim 61, further comprising optimizing the  
2     identified objects by restoring a volume of the datastore and recovering corresponding  
3     objects.

1           87.     The article of manufacture of claim 61, further comprising optimizing the  
2     identified objects by grouping the identified objects, wherein the grouped objects have  
3     backups residing on the same volume of the datastore.

1            88.     The article of manufacture of claim 61, wherein an object is associated with  
2     different units of recovery, wherein one or more units of recovery require different levels of  
3     processing, and wherein the object is recovered utilizing the highest level of processing.

1            89.     The article of manufacture of claim 61, wherein the one or more individual  
2     objects to be recovered to a target time are recovered from a current time.

1           90.     The article of manufacture of claim 79, wherein the current time represents at  
2     time at which the database system crashed.